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Provider Attitudes Regarding Vaccine Tracking Systems in Pediatric Practices

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Abstract

Objective—To assess among US pediatricians' systems for tracking vaccine administration and inventory and attitudes about these systems; and attitudes regarding and perceived barriers to adoption of a 2-dimensional bar code systems.

Methods—Internet and mail survey of a nationally representative network of pediatricians between September 2011 and January 2012.

Results—The response rate was 71% (288 of 408). The most common methods for recording vaccine information were manual entry into an electronic (52%) or paper (27%) record; 76% recorded information in ≥2 places. Physicians reported ordering vaccine on the basis of seasonal increases in demand (55%), paper-based inventory (52%), or when stock looks low (47%); 79% reported it was time consuming to track inventory and 24% reported their practices frequently run out of vaccines. Among those participating in an immunization information system, 29% transmitted data by automatic uploads and 58% entered data manually. Physicians agreed that bar codes could facilitate tracking of vaccine inventory (96%), would improve patient safety (96%), would be more reliable and accurate than current systems (93%), and could improve the efficiency of vaccine administration (90%). Barriers to adoption of a bar code system included need for software (52%), information technology support (42%), and computer equipment (33%). The total cost at which >50% reported they would definitely or probably adopt a bar code system was between $1000 and $4999.

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SUPPLEMENTARY DATA

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Conclusions—Most pediatricians report using inefficient systems for tracking vaccine administration and inventory and recognize multiple potential benefits of incorporating vaccine bar coding into their practice. To facilitate adoption, costs will need to be contained and technological barriers addressed.

Keywords

immunization; vaccine bar code; vaccine inventory; vaccine tracking

The improvements in efficiency, cost, and quality of care that are expected with universal adoption of health information technology have not yet been fully realized,[1] and systems for recording vaccine administration information and tracking vaccine inventory are no exception. In 1992, the National Vaccine Advisory Committee (NVAC) developed the Standards for Pediatric Immunization Practice to guide health care providers on best practices regarding the provision of immunizations,[2] which were subsequently updated in 2002.[3] Several of the 17 standards address the practices of recording vaccine administration and tracking vaccine inventory, including using accurate and complete recording procedures and adhering to appropriate procedures for vaccine management. When an immunization is administered to a patient, the administering provider is required to record details of the vaccination encounter,[4] including the type of vaccine given, date of administration, manufacturer, lot number, location of administration, and identifying information of the persons administering and receiving the vaccine.[5] In addition, the American Academy of Pediatrics suggests recording expiration date.[6] Data should also be uploaded into a state or regional immunization information system (IIS) so that immunizations can be consolidated and tracked at the population level. These data serve multiple important functions. Clinically, they are the record of receipt of immunization and provide sufficient information to recall patients if there are concerns about a specific vaccine lot. These data may be used to track the practices' vaccine supply/stock, which is important in decreasing missed opportunities for vaccination by ensuring adequate supply and decreasing the potential for vaccine waste from stocking vaccine which expires before it is used.[7]

Such a fully integrated system will still rely on optimal entry of the data. The entry of vaccine administration and inventory data is vulnerable to inaccuracy and incompleteness, particularly when records are handwritten and/or recorded in multiple places.[8,9] A new tool, 2-dimensional (2-D) bar codes, has been proposed to help health care providers decrease inefficiencies and inaccuracies related to recording vaccine administration information and tracking vaccine inventory.[10] Currently, 2-D bar codes on the label of a vial or syringe of vaccine products contain expiration date, lot number, and National Drug Code; therefore, if the proper software configurations were in place, 2-D bar code systems could improve data capture into patient records and subsequent reporting to IIS by providing data about vaccine lot numbers, expiration dates, and manufacturer information. The Centers for Disease Control and Prevention (CDC) currently is involved in a pilot study in several states with over 200 immunization providers to further assess the barriers and determine the best practices for tracking vaccines using 2-D bar codes.[11] Presently, there are a limited number of vaccines labeled with 2-D bar codes, although this should increase in the coming years as

manufacturers, which are active participants in the adoption of bar codes, modify their labels.

Since the NVAC last updated the Standards for Pediatric Immunization Practice in 2002, there has been little evaluation of pediatricians' processes related to recording vaccine administration and tracking vaccine inventory. Therefore, we sought to evaluate both current practices and receptiveness to new technologies for managing and improving data around vaccine documentation and inventory control. Our objectives were to assess among US pediatricians current systems for recording vaccinations and tracking vaccine supplies and attitudes about these systems and attitudes regarding and barriers to adoption of 2-D bar code systems.

Methods

Between September 2011 and January 2012, we administered an Internet and mail survey to a national network of pediatricians. The human subjects review board at the University of Colorado Denver approved this study as exempt research not requiring written informed consent.

Study Population

The Vaccine Policy Collaborative Initiative conducted this study.[12] The Initiative is a program designed collaboratively with the CDC to perform rapid turnaround surveys assessing physician practices and attitudes about vaccine issues. We developed a national network of primary care physicians for this program by recruiting pediatricians from the American Academy of Pediatrics (AAP). We conducted quota sampling to ensure that network physicians were similar to the AAP membership with respect to region, urban versus rural location, and practice setting. To construct the network, we first determined proportions of US pediatricians falling into each cell of a 3-dimensional matrix that crossed US region (Northeast, South, Midwest, or West), practice location (urban inner city, suburban, or rural), and type of practice (private, hospital/university/community health center, or managed care). Proportions for each cell in the 36-cell matrix were applied to a total sample size of 400 to create cell sampling quotas. The sample size of 400 was selected for a maximum estimated confidence interval of ±5 percentage points on estimates. Physicians provided their preference for future contact (e-mail or mail) at the time of recruitment. We previously demonstrated that survey responses from network physicians compared to those of physicians randomly sampled from American Medical Association physician databases had similar demographic characteristics, practice attributes, and attitudes about a range of vaccination issues.[12]

Survey Design

We developed the survey jointly with the CDC with input from experts in pediatric office practice and IIS. The survey was pretested with a panel of 5 pediatricians and then piloted among 9 pediatricians from different regions of the country. Using 4-point Likert-type responses, questions assessed attitudes about current systems for recording vaccine information and tracking vaccine inventory. Responses to information questions were either

yes/no, with answers that were not mutually exclusive, or selections from a list of possible options. After a brief description of 2-D bar code systems, questions regarding attitudes and barriers to use of bar code systems were asked using 4-point Likert scales. Physicians were also asked to rate potential features of bar code systems as "crucial to adoption" or "not crucial to adoption." Finally, physicians were asked how likely they would be to adopt a bar code system given various cost scenarios from under $100 or free to more than $20,000. Physicians were asked to consider all potential costs of adopting a bar code system, including equipment, software, and information technology support. The survey instrument is available as on online appendix.

Survey Administration

We surveyed physicians by the Internet or, if they preferred, by mail. We used a Web-based program (Verint, Melville, NY; http://www.verint.com) to administer Internet surveys, and we sent mail surveys by the US Postal Service. We sent the Internet group an initial e-mail with up to 8 e-mail reminders, and we sent the mail group an initial mailing and up to 2 additional reminders. For mail surveys that were returned or undeliverable, we confirmed new addresses for those physicians and proceeded with the mail protocol. We sent Internet survey nonrespondents a crossover mail survey in case of problems with e-mail correspondence (including e-mails that bounce). We patterned the mail protocol on the tailored design method of Dillman et al.[13] Respondents from New Hampshire were excluded from questions regarding IIS because New Hampshire did not have an IIS at the time of the study.

Statistical Analysis

We pooled Internet and mail surveys together for analyses because other studies have found that physician attitudes are similar when obtained by either method.[14] We compared respondents with nonrespondents on all available characteristics using Wilcoxon and chi-square analyses. For relevant questions, where differences existed, responses were reported on the basis of whether or not respondents practiced in a state with an IIS with a mandatory reporting requirement[15] and whether or not respondents were in a large (≥5 providers) or small (<5 providers) practice. Because of the high number of comparisons within these bivariate analyses, we considered statistical significance as <0.01. Analyses were performed using SAS software, version 9.2 (SAS Institute, Cary, NC).

Results

The survey response rate was 71% (288 of 408; e-mail 77% [221 of 287], mail, 55% [67 of 121]). Respondents were similar to nonrespondents with respect to age, gender, practice setting, practice location, region of the country, size of practice, and whether or not they were in a state that requires mandatory reporting of vaccinations to the state or regional IIS (Table 1).

Methods for Recording Vaccine Doses and Tracking Vaccine Inventory

The most commonly reported methods for recording vaccine product, lot number and expiration date were direct entry into an electronic (52%) or paper-based (27%) medical

record. Seventy-six percent reported recording vaccine information in 2 or more places and 40% reported doing so in 3 or more places. Larger practices were more likely to record vaccine doses in an electronic record (55% vs 44%) and less likely in a paper record (22% vs 37%, $P < .001$). The most common places for recording vaccine information were the medical record (either paper-based or electronic medical record/electronic health record [EHR], 93%), an IIS (50%), and a patient handheld record (39%). Respondents from a state with mandatory IIS reporting were more likely to report recording vaccine information in an IIS (67% vs 42%, $P < .001$). Sixty-eight percent reported using 2 or more methods and 43% used 3 or more methods for recording vaccine information. Physicians in larger practices were more likely to report "I don't know" in response to the question regarding their current system for recording vaccination information in the medical record (22% vs 5%, $P < .001$).

Physicians reported ordering vaccine based on expected seasonal increases in demand (55% overall, smaller practices 71%, larger 47%, $P < .001$), using a paper-based inventory (52%), or simply ordering when stock looks low (47%). Fewer physicians reported using IIS- or Internet-based inventory systems (21%) or computerized inventory software systems (9%).

While many physicians reported general satisfaction with their current systems, 87% agreed that "recording vaccine doses in the patient's record takes a lot of time at my practice" and 79% agreed that "tracking vaccine inventory takes a lot of time at my practice" (Fig. 1). Twenty-four percent reported their practices frequently run out of vaccines.

Awareness and Use of IIS

Among respondents, 75% reported that their state/region had an IIS, 8% reported that they did not, and 18% were unsure. Among those *aware* of an IIS, 80% reported participation in the IIS. Overall, 59% reported participating in an IIS. There were not significant differences in awareness or reported participation in IIS between respondents in mandatory versus nonmandatory IIS-reporting states or large versus small practices. Of those participating in an IIS, there were differences between smaller and larger practices in how they reported transmitting data to the IIS, with smaller practices less often transmitting by automatic uploads (smaller practices 15%, larger practices 36%) and more often reporting that they had to enter data manually (smaller practices 79%, larger practices, 48%) ($P < .01$ for overall comparison). Few (0% smaller practices, 3% larger practices) faxed data to the IIS, or reported other ways (4% smaller practices, 3% larger practices). Physicians from larger practices more often reported that they were not sure how data were transmitted (2% smaller practices, 11% larger practices). Among those physicians who reported having an EHR (66% overall, 53% smaller practices, 73% larger practices; $P < .01$) and who knew their state had an IIS (75%) and participated in the registry (78%), 38% reported they transmitted data by automatic uploads.

Attitudes and Barriers Regarding the Adoption of a Bar Coding System

Pediatricians reported generally favorable attitudes toward a 2-D bar coding system (Fig. 2). The vast majority agreed that bar codes would be more reliable and accurate than current systems (93%), that they would improve efficiency of vaccine administration (90%), that they could facilitate tracking of inventory (96%), and that they would improve patient safety

(96%). When asked what features would be crucial to adoption of a hypothetical bar code system, physicians reported the following features: identifying patients who have received a recalled lot of vaccine (89%), recording doses in an EHR (86%), maintaining vaccine inventory (82%), automatically transmitting information to an IIS (69%), billing for vaccine doses (66%), and recording that a VIS was given to a patient (64%). The most commonly reported moderate or major barriers to adoption of a bar code system (Table 2) were the need for software (52%), the need for information technology support (42%), and the need for computer equipment (33%). The total cost at which more than half of pediatricians reported they would definitely or probably adopt a bar code system was between $1000 and $4999 (Fig. 3).

Discussion

This national study was conducted to assess in detail pediatricians' current systems for recording vaccine administration and tracking vaccine inventory and attitudes related to adoption of bar codes to aid in these efforts. We found that methods for recording vaccine administration and tracking inventory were often duplicative and time-consuming, and that, for most pediatricians who participate in an IIS, double data entry rather than electronic uploads was the method of submitting data. While pediatricians reported positive attitudes regarding the adoption of a bar code system for vaccines, they also reported numerous features that would be essential for adoption, and clear requirements for affordability.

Our findings present a snapshot as practices transition from paper based records to EHRs. Two-thirds of physicians in our study reported that they had an EHR, which is similar to a recent report from the National Center for Health Statistics.[16] However, similar to previous studies, we found that simply having an EHR does not necessarily increase efficiency.[17] For example, we found that the practice of double data entry is common even among those who have an EHR and participate in an IIS, with a minority of providers automatically uploading data to an IIS, even in larger practices. Some posit that some EHR vendors purposely avoid interoperability to protect their market share, holding clients hostage to EHRs that reduce efficiency and prevent innovation.[18] Policy makers should consider continuing to incentivize interoperability such as through further meaningful-use revisions,[19] and pediatric practices should demand it when considering EHR purchases and upgrades.

A somewhat surprising finding of our study was the complete lack of a standard approach to tracking vaccine inventory. Most physicians reported using multiple methods for tracking inventory, often ordering on the basis of seasonal demand or simply when stock looks low. Almost no physicians were using automated or integrated systems, and three-quarters of providers reported that the inventory process was time consuming. Given this lack of a standard approach to tracking inventory, it is not surprising that one-fourth of respondents reported that their practice frequently runs out of vaccine. Better and more efficient methods of tracking vaccine inventory have the potential to decrease staff time and also prevent running out of vaccine or waste due to expiring vaccines.

The use of 2-D bar codes on vaccines may offer one part of a solution to the problems of double data entry, inaccurate or incomplete data capture, and time consuming tracking of

inventory. One could envision a system in which a child is administered a vaccine, and the administering provider scans the vaccine vial with a 2-D bar code scanner, which then populates the patient's medical record that the dose was administered, including all relevant details about the vaccine, such as expiration date, lot number, and manufacturer. This information could be then seamlessly transmitted by the EHR to the practice's billing and inventory management systems and automatically uploaded to the IIS, which could also potentially be used to track inventory.[20]

Adoption of this hypothetical system could facilitate health care providers' use of an IIS by automating data entry into the IIS,[21] and aid in the transition to Meaningful Use for eligible providers. Meaningful Use incentivizes adoption of IIS, with the objective that EHRs submit electronic data to IISs except where prohibited, with an outcome measure of successful ongoing submission of electronic immunization data from certified EHR technology.[22] While reporting to IIS is mandatory in some states, most have voluntary participation. Increasing participation in IIS in those nonmandatory reporting states is also important because IIS have been shown to be effective for increasing vaccination coverage.[20] For both mandatory and nonmandatory reporting states, data entry into IIS with 2-D bar code scanning also has the potential to improve IIS data quality. While essentially all IIS have the ability to capture information such as vaccine lot number and vaccine manufacturers, these data elements are complete in only 60% and 63% of IIS records, respectively.[10] Data from a fully integrated system would also be available for downstream use by vaccine safety surveillance mechanisms, such as the Vaccine Adverse Event Reporting System (VAERS), the Vaccine Safety Datalink (VSD), or other future vaccine safety surveillance systems.

The promise of 2-D bar codes as part of a solution to some of the vaccine tracking and inventory management problems—as well as the interoperability with IIS—should not be overstated however. At a basic level, a bar code scanner is simply an input device. Several of the functions that many of our respondents considered crucial to adoption of a bar code system, such as the ability to record vaccines doses in an EHR, maintain inventory, and automatically upload to an IIS, are not part of the price tag of a bar code scanner. In some cases, where a software solution to incorporating a bar code scanner into an EHR already exists, many of the desired features associated with the use of bar code scanners will be available. In other settings, however, such as not having an EHR, or having an EHR that cannot efficiently take the scan data and use it to populate key data items, the benefits to the adoption of bar code scanners are harder to imagine. Interoperability with the IIS and bar code utilization are challenging issues, both of which will need to be addressed to meet the full potential of an integrated and useful vaccine network.

Pediatricians are not naïve to the potential system problems of 2-D bar code scanners: the most common barriers to the adoption of this technology that were identified in our survey were computer related, including technology support and the need for software and hardware. A recent feasibility study reinforces the notion that interoperability will be important to promote adoption of 2-D bar code technology. RTI International, a nonprofit research group, contracted with CDC to study the impacts 2-D bar codes may have on vaccine production, documentation, and public health reporting and tracking for immunization stakeholders.[23] One of the conclusions was that while EHRs are not required

for the use of bar codes, EHRs with the ability to receive scanned data are necessary to take the fullest advantage of the use of 2-D bar codes. Regarding cost as a potential barrier, two-thirds of our respondents would adopt a system if the cost were $1000 to $5000, and almost all would if the total cost were under $1000. A recent cost–benefit analysis estimated that while adoption of 2-D bar code systems would result in a favorable benefit-to-cost ratio overall, the cost of adoption for a pediatric practice would be between $1016 and $7831, depending on practice size.[24] However, that estimate did not include the software or hardware that may be required to realize many of the functions desired by pediatricians in our survey, nor did it include ongoing maintenance or quality checks. The estimate also did not take into account the cost of an EHR. For practices that already have an EHR that has the ability to accept a 2-D bar code scan, though, the cost of adoption would be little more than the cost of the scanner itself, which, for a single scanner can cost anywhere from a few hundred to several hundred dollars, depending on desired features. As bar code technology is rolled out for vaccines, manufacturers, EHR providers, and state IIS should work together to make the transition as seamless as possible, and cost must be a consideration. To address the problem of technology underutilization, the CDC has published a resource guide to aid in the adoption of bar code technology.[25,26]

This study has several strengths and limitations. It was from a national sample of pediatricians, and there was a high response rate. However, respondents' attitudes and practices may have differed from nonrespondents, and network physicians may differ from physicians overall, although prior work suggests otherwise.[12] It is also should be noted that these were the responses of pediatricians who may not be the most knowledgeable people in a given practice regarding vaccine administration and inventory management. We did, however, offer respondents the choice of "don't know" and have reported those results. Also, despite this clear limitation, pediatricians are often the primary decision makers in a given practice, and their attitudes and perceptions are therefore important, even if not always entirely accurate. Finally, questions regarding bar codes were hypothetical and may not reflect eventual practice.

Conclusions

On the basis of this survey among practicing pediatricians, current systems of recording vaccine doses and tracking vaccine inventory are duplicative, time-consuming and often not linked to the IIS. While the technology exists to streamline these processes and improve efficiency, such technology appears to be underutilized. The use of 2-D bar codes offers one part of a potential solution to many of the present problems with record keeping for vaccine administration and inventory, but to be successful must have good technical support, the capability to fully integrate with EHRs and IIS, and be affordable for practices.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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What's New

Pediatricians report inefficient systems for recording vaccine information and tracking vaccine inventory, with many recording vaccine information in 2 or more places.

Pediatricians are amenable to adoption of 2-dimensional bar code systems, but costs must be contained and technological barriers addressed.

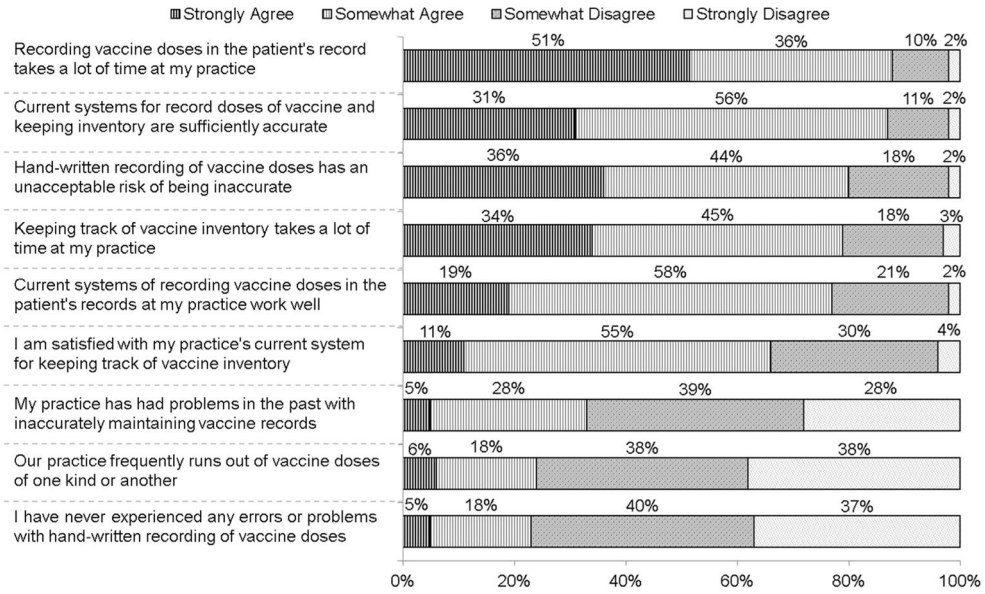

Figure 1.

Pediatricians' attitudes regarding recording vaccine administration information and tracking vaccine inventory.

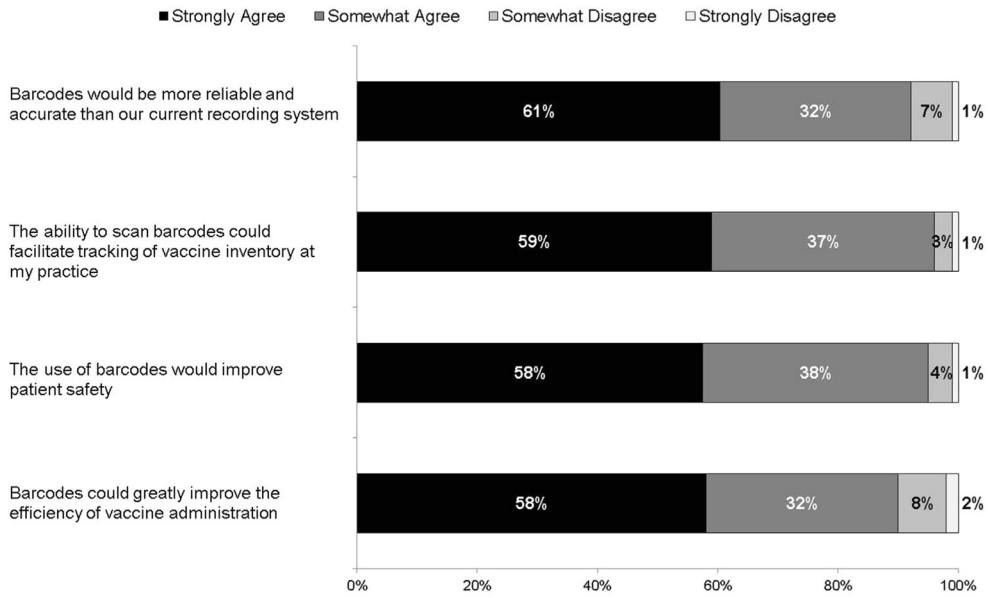

Figure 2.

Pediatricians' attitudes regarding possible use of a barcoding system for recording vaccine information.

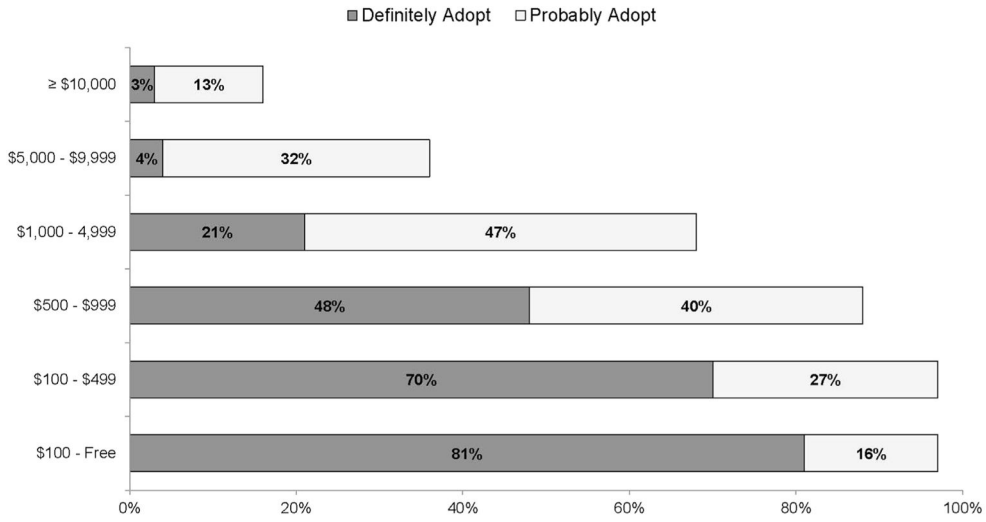

Figure 3.

Pediatricians' reported likelihood of adoption of a hypothetical barcoding system for vaccines given specific costs.

Table 1

Characteristics of Survey Respondents and Nonrespondents

Characteristic	Respondent (n = 288), n (%)	Nonrespondent (n = 120), n (%)	*P*
Male, n (%)	113 (39.2)	50 (42.4)	.56
Age, y, mean (SD)	49.7 (10.2)	50.9 (10.3)	.30
Region, n (%)			
Midwest	59 (20.5)	24 (20.0)	.24
Northeast	58 (20.1)	35 (29.2)	
South	106 (36.8)	39 (32.5)	
West	65 (22.6)	22 (18.3)	
Practice location, n (%)			
Urban, inner city	124 (43.2)	51 (42.5)	.97
Urban, non–inner city/suburban	128 (44.6)	55 (45.8)	
Rural	35 (12.2)	14 (11.7)	
Practice setting, n (%)			
Private practice	231 (80.2)	94 (78.3)	.13
Hospital or clinic	42 (14.6)	24 (20.0)	
HMO	15 (5.2)	2 (1.7)	
In mandatory reporting state, n (%)			
Yes	195 (67.7)	73 (60.8)	.18
No	93 (32.3)	47 (39.2)	
No. of providers in practice, n (%)			
<5	98 (34.0)	52 (43.7)	.07
≥5	190 (66.0)	67 (56.3)	
Patients with Medicaid, n (%)			
<10%	95 (33.9)	NA	
10–24%	74 (26.4)	NA	
25–49%	56 (20.0)	NA	
≥50%	55 (19.6)	NA	
Hispanic or Latino patients, n (%)			
<10%	151 (53.6)	NA	
10–24%	81 (28.7)	NA	
25–49%	31 (11.0)	NA	
≥50%	19 (6.8)	NA	
Black or African American patients, n (%)			
<10%	135 (48.1)	NA	
10–24%	80 (28.5)	NA	
25–49%	54 (19.2)	NA	
≥50%	12 (4.3)	NA	

Table 2

Pediatricians' Reported Barriers to Adoption of Bar Code System for Vaccines

Characteristic	Major Barrier	Moderate Barrier	Minor Barrier	Not at All a Barrier
Need for software	16%	36%	32%	16%
Need for information technology/support	13%	29%	38%	19%
Lack of electronic medical record	15%	13%	6%	67%
Need for computer equipment	11%	22%	25%	43%
Need for training	8%	23%	46%	23%
No. of locations at which we prepare vaccines at our practice	7%	25%	34%	35%
Would disrupt work flow	6%	17%	25%	53%

Some percentages do not add to 100 as a result of rounding.